APPENDIX A
GEOPHYSICAL SURVEY REPORT

Sub Surface Surveys
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June 19, 2000

Project Number: 00-158

PSI
3960 Gilman Street
Long Beach CA 90815

Attn: **Jeff Friedman**

Re: **CalTrans- Hannon Ranch Project borehole clearance, Imperial Valley, CA**

This brief letter report is to present the findings of our geophysical surveys conducted at the CalTrans Hannon Ranch Project located at the southeast corner of Schartz Road and the Hwy 111 in Imperial Valley, California (Fig.1) on May 31, 2000. The purpose of the survey was to locate and delineate the surface projection of pipes/utilities in the vicinity of planned drilling activities. A combination of ground penetrating radar (GPR), magnetic gradiometer, electromagnetic induction (EM), and a line tracer were applied to the search.

Multiple methods were utilized because each instrument senses different material properties of the ground and buried objects. At any given site, the situation, geologic and cultural, may be such that one or more of the instruments may record excessive "noise", the ground may not provide sufficient contrasts with installations or discards, or there may be overlapping anomalies, and those instruments may not be definitive. Generally, however, the interpretation is based on the best reconciliation of the several data sets acquired.

<u>Survey Design</u> – 31 proposed boring locations around the ranch property were investigated with the geophysical instrumentation. To the extent that access permitted, the planned boring locations were to be cleared by traversing with geophysical instruments along the eight lines of the standard search pattern (Fig. A), wherein, there are two sets of three parallel lines, mutually orthogonal, and two diagonals, all centered on the marked drill location. Adjacent parallel lines are approximately 4 feet apart, and each line is approximately 25 feet long, access permitting. Other traverses were taken, access permitting, for detailing and confirmation where anomalous conditions were found.

Each of the geophysical instruments utilized are effective at detecting and delineating structures/objects constructed of metallic materials. GPR is especially useful in that it is the only instrument applied that is capable of detecting nonmetallic objects, image objects below rebar, and image backfilled trenches. According to theory, Radar penetration is a function of soil conductivity and dielectric constant. At this site local conditions were reasonably favorable due to soil conditions. This resulted in Radar penetration down to only between 2 and 3 feet.

GPR traverses appear to have been successful in delineating the limits of a backfilled excavation located north of the diesel tanks (See photo Fig. 20). Example radar records are presented on figures 21 and 22 in order to illustrate GPR data quality. Figure 21 is an image produced while traversing south to north over the suspected backfilled excavation. Figure 22 is an image produce while traversing west to east over the suspected backfilled excavation. Figures 23 and 24 are presented to illustrate the EM61 and radar respectively, in use at the site.

<u>Conclusions</u> – Thirty-one proposed boring locations were investigated with the geophysical instruments, and appear clear of utilities and/or other possible hazards to drilling as marked by Subsurface Surveys. All piping, utilities and/or conduit identified during our investigation, in the vicinity of the borehole sites were marked with paint on the ground cover of the site.

All data generated on this project are in confidential file in this office, and are available for review by authorized persons at any time. The opportunity to participate in this investigation is very much appreciated. Please call, if there are questions.

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Patrick F. Lehrmann
Staff Geol/Geophysicist

Lawrence J Favilla

Lawrence J. Favilla, GP969
Senior Geophysicist

Sub Surface Surveys

SITE LOCATION MAP

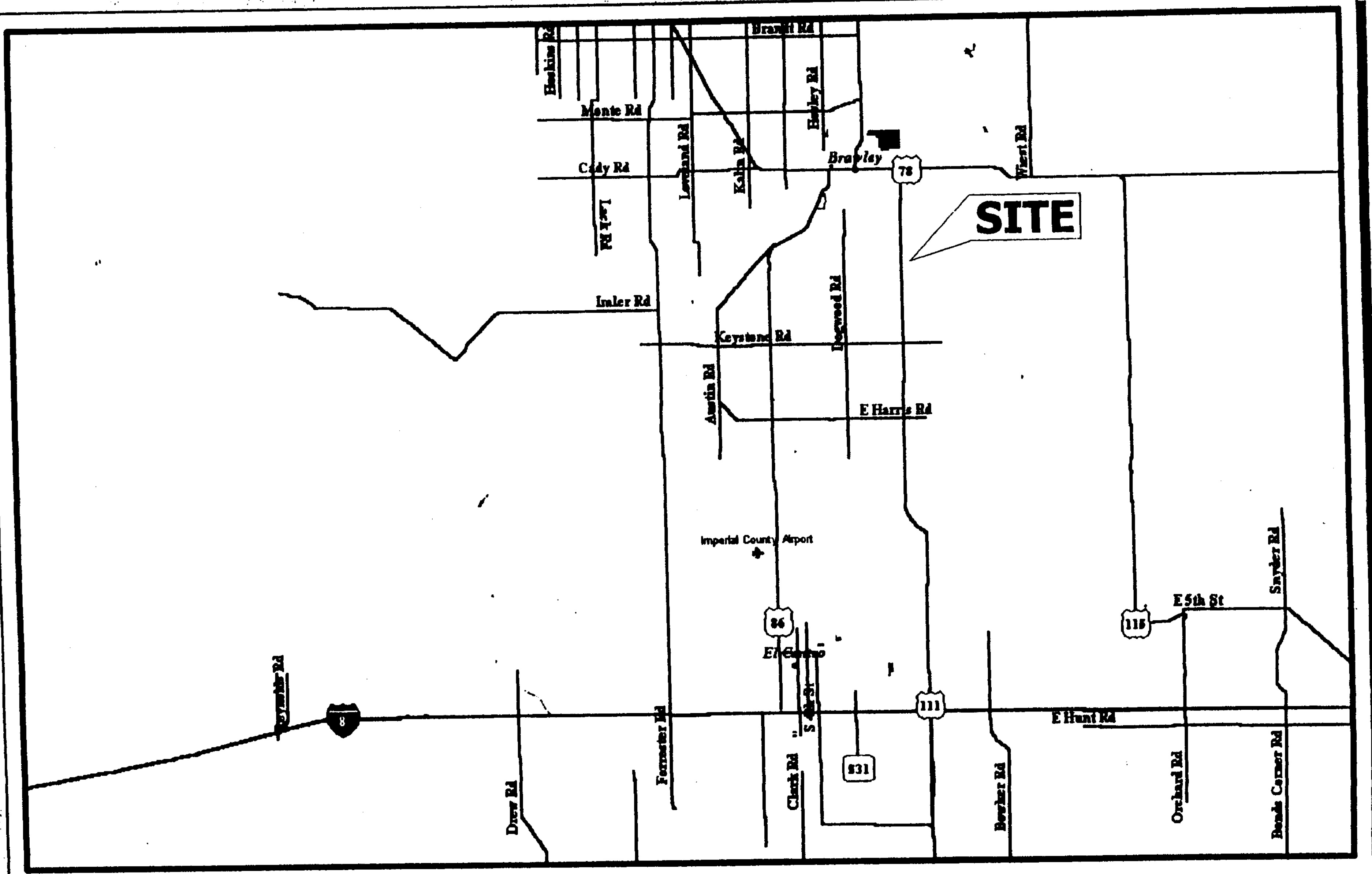


FIGURE 1

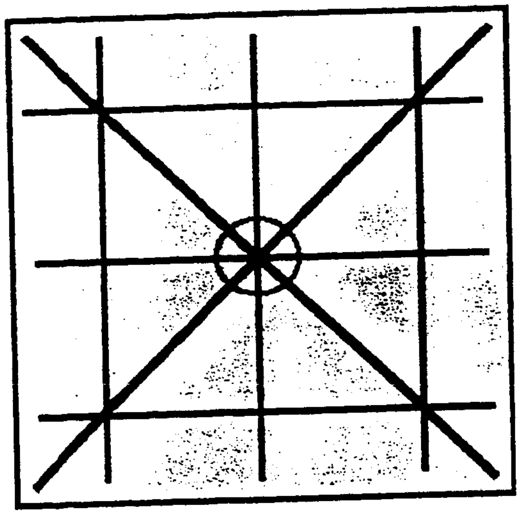


Figure A: Standard search pattern around borehole

Hard copy of the EM and magnetic gradient data was not acquired, that is, discreet readings on the nodes of a grid were not recorded. Rather, the instrument's meter was monitored continuously during traverses to detect excursions of the readouts that might have meaning in terms of buried objects. The lack of hard copy for the magnetic data set does not degrade the quality of the survey in any way. The higher sampling rate achieved with continuous monitoring of the instruments is the best way to attempt to discriminate buried features from surface metallic objects, in sites such as this one. The GPR output, of course, is in hard copy form, and position and direction of traverses were noted on the records as they were produced.

Geonics models EM-31 and EM-61 instruments were used for the EM sampling. A Sensors & Software Noggin Ground Penetrating Radar unit produced the radar images, the magnetic gradiometer was a Schonstedt, model GA-52C, and the line tracer used was a Metrotech 9860.

Brief Description of the Geophysical Methods Applied - The EM-31 and M-scope TW-6 devices energize the ground by producing an alternating primary magnetic field with ac current in the transmitting coil. If conducting materials are within the area of influence of the primary field, ac eddy currents are induced to flow in the conductors. A receiving coil senses the secondary magnetic field produced by these eddy currents, and outputs the response to a meter in the form of ground conductivity values in the case of the EM-31. The strength of the secondary field is a function of the conductivity of the object, say a pipe, tank or cluster of drums, its size, and its depth and position relative to the instrument's two coils. Conductive objects, to a depth of approximately 18 feet for the EM31 and 10 feet for the M-scope, are sensed. Also the devices are somewhat focused, that is, they are more sensitive to conductors below (and above) the instrument, than to conductors off to the side.

The EM-61 instrument is a high resolution, time-domain device for detecting buried conductive objects. It consists of a powerful transmitter that generates a pulsed primary magnetic field when its coils are energized, which induces eddy currents in nearby conductive objects. The decay of the eddy currents, following the input pulse, is measured by the coils, which in turn serve as receiver coils. The decay rate is measured for two coils, mounted concentrically, one above the other. By making the measurements at a relatively long time interval (measured in milliseconds) after termination of the primary pulse, the response is nearly independent of the electrical conductivity of the ground. Thus, the instrument is a super-sensitive metal detector. Due to its unique coil arrangement, the response curve is a single well defined positive peak directly over a buried conductive object. This facilitates quick and accurate location of targets. Conductive objects, to a depth of approximately 11 feet can be detected.

The magnetic gradiometer has two fluxgate magnetic fixed sensors that are passed closely to and over the ground. When not in close proximity to a magnetic object, that is, only in the earth's field, the instrument emits a sound signal at a low frequency. When the instrument passes over a buried iron or steel object, so that the field is significantly different at the two sensors, and locally magnetic gradient, the frequency of the emitted sound increases. Frequency is a function of the gradient between the two sensors.

Where risers are present, the utility locator transmitter can be connected to the object, and a current with a sharp frequency, 82 kHz in this instance, is impressed on the conductor, pipe conduit, etc.. The receiver unit is tuned to this same frequency, and it is used to trace the pipe's surface projection away from the riser.

The GPR instrument beams energy into the ground from its transducer/antenna, in the form of electromagnetic waves. A portion of this energy is reflected back to the antenna at any boundary in the subsurface across which there is an electrical contrast. The recorder continuously makes a record of the reflected energy as the antenna is traversed across the ground surface. The greater the electrical contrast, the higher the amplitude of the returned energy. The EM wave travels at a velocity unique to the material properties of the ground being investigated, and when these velocities are known, or closely estimated from ground conductivity values and other information, two-way travel times can be converted to depth.

Penetration into the ground and resolution in the GPR images produced are a function of ground electrical conductivity and dielectric constant. Images tend to be graphic, even at considerable depth, in sandy soils, but penetration and resolution may be limited in drastically more conductive clayey moist ground.

Interpretation - The interpretation took place in real time as the survey progressed, and accordingly, the findings of our investigation were marked on the ground. The intent of this document is to demonstrate the procedure, and report the findings of the work.

In searching the area, utilities detected were marked on the ground surface with paint, (red for electric, blue for water, yellow for gas, etc.) and consequently, the borings were moved to safe locations, marked out with a white circle, and marked "OK" when cleared (See photos of boring locations Figures 2 through 19).

Sub Surface Surveys

SITE PHOTOGRAPHS

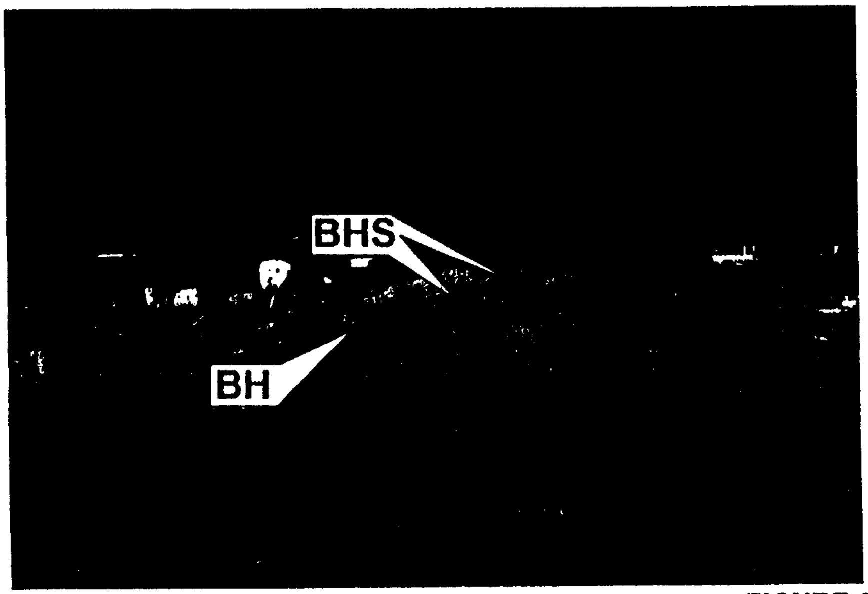


FIGURE 2

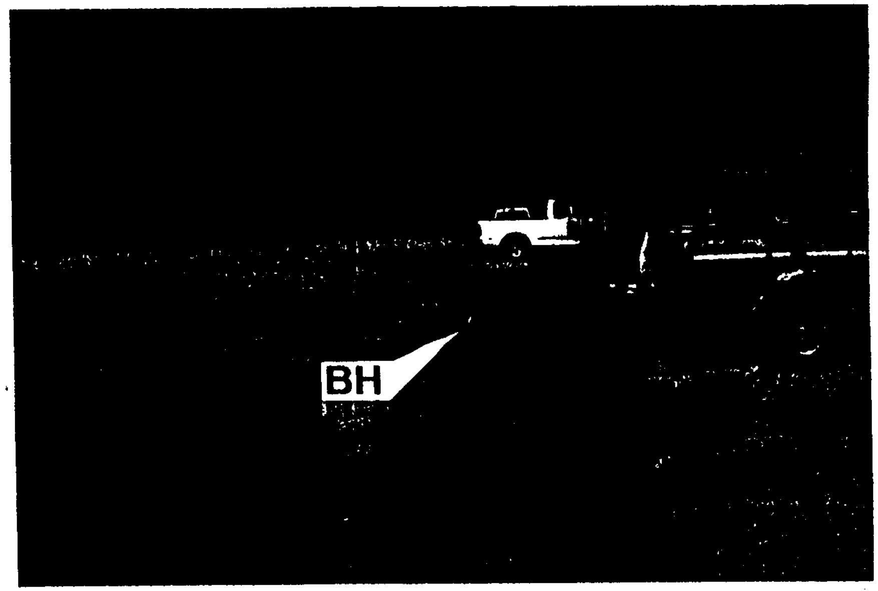
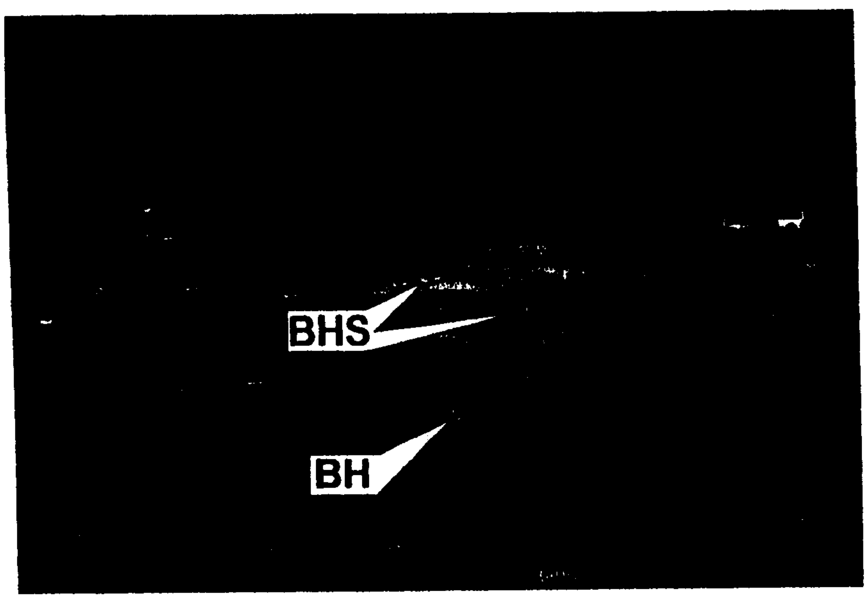


FIGURE 3



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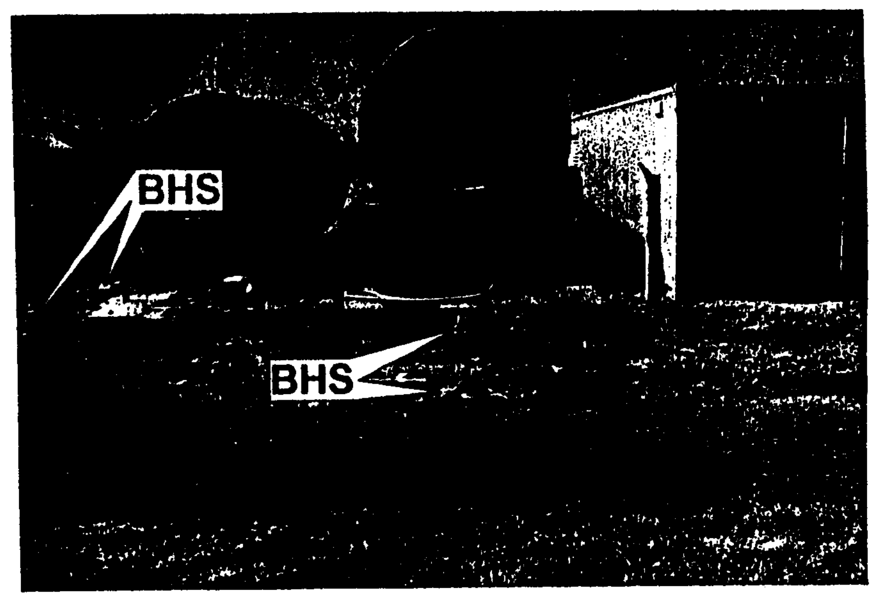
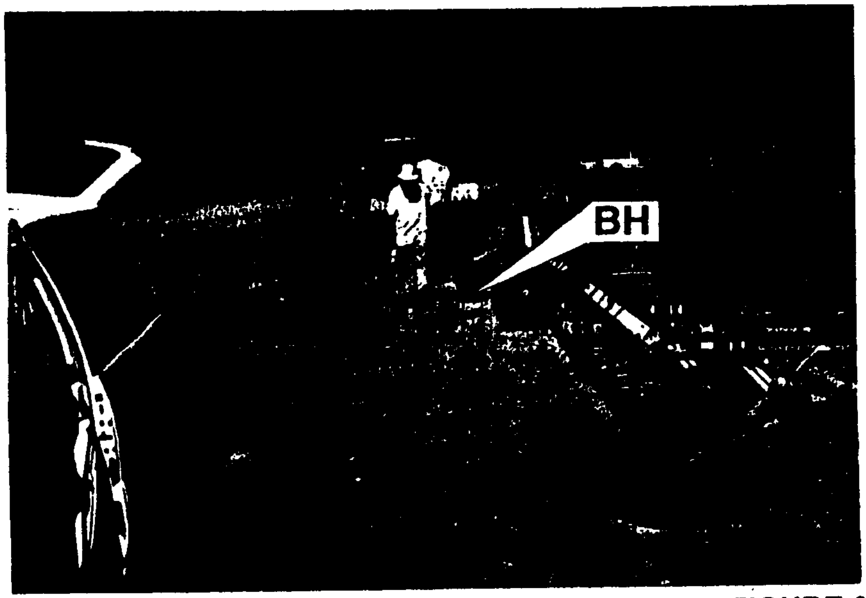


FIGURE 5

Sub Surface Surveys

SITE PHOTOGRAPHS



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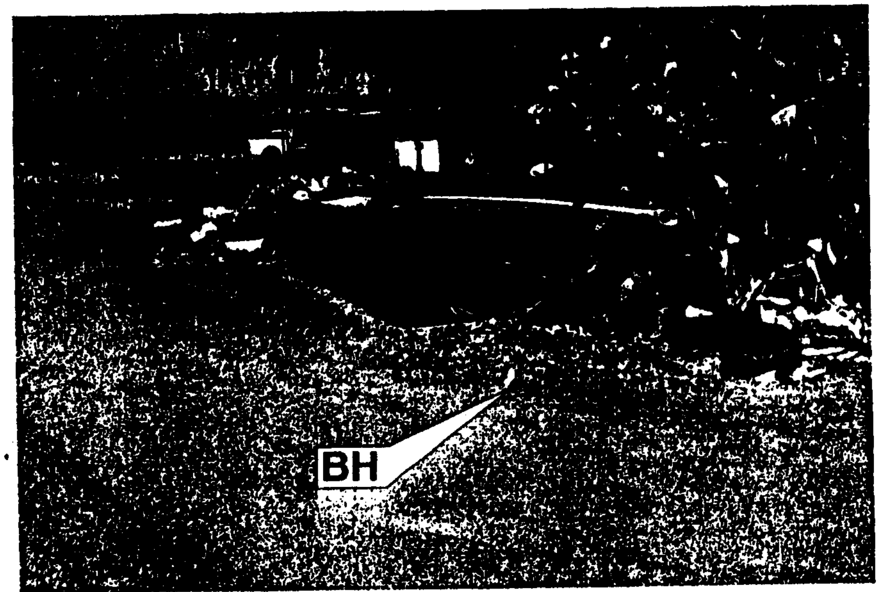


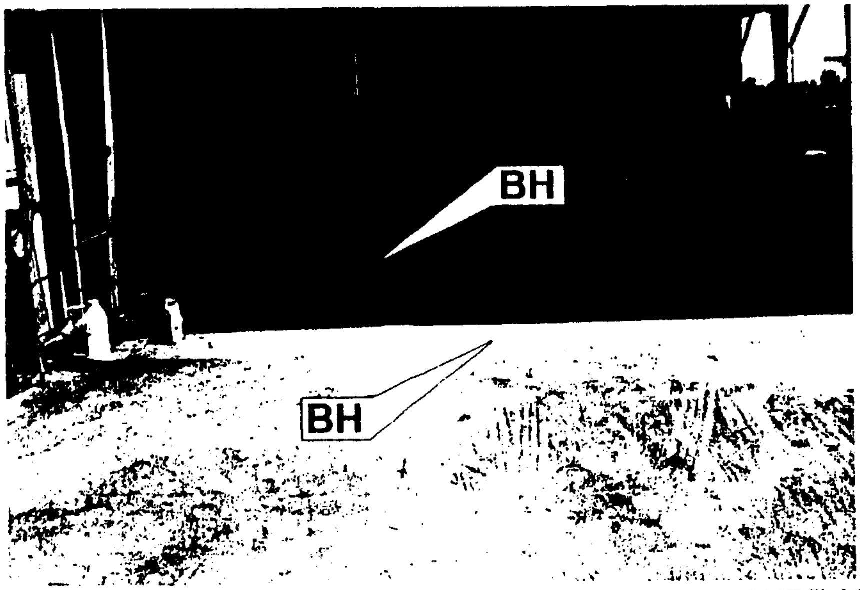
FIGURE 7

FIGURE 8

FIGURE 9

Sub Surface Surveys

SITE PHOTOGRAPHS



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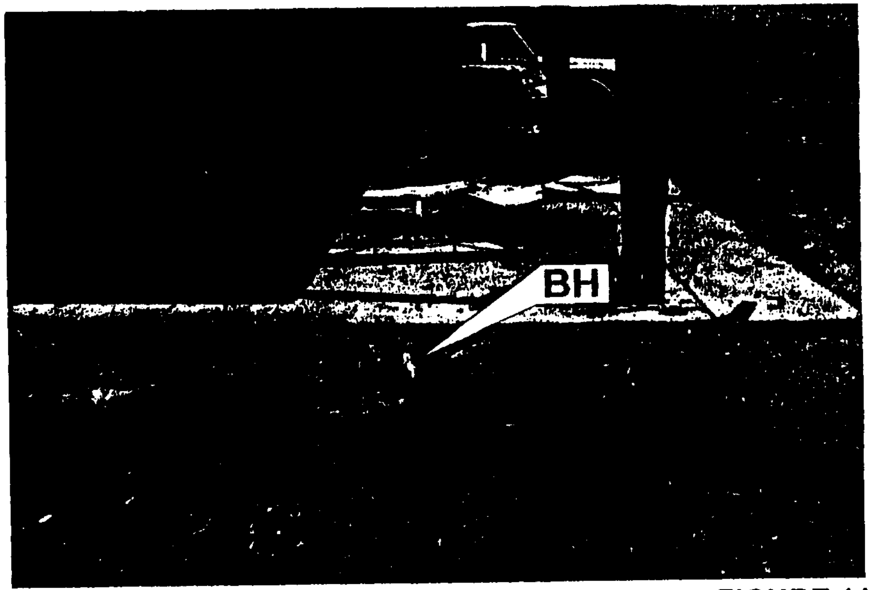

FIGURE 11

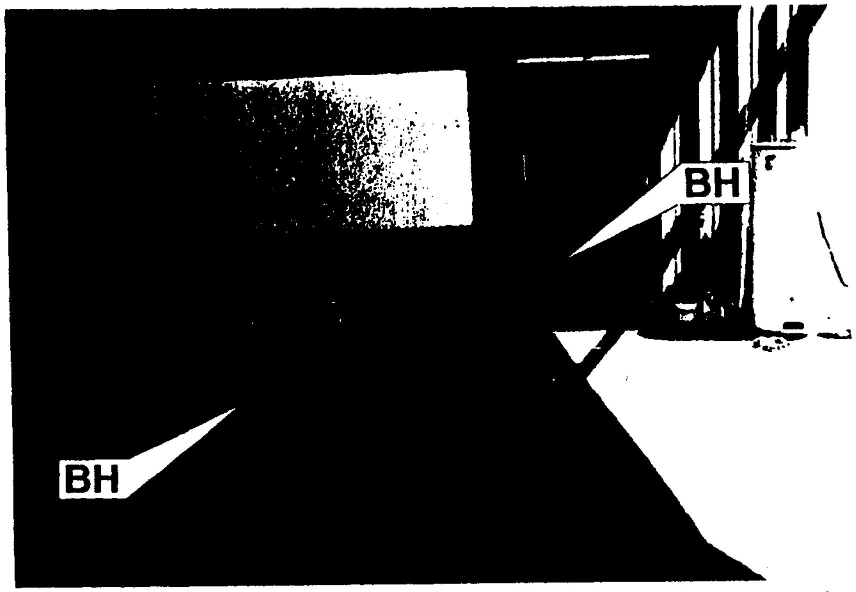

FIGURE 12

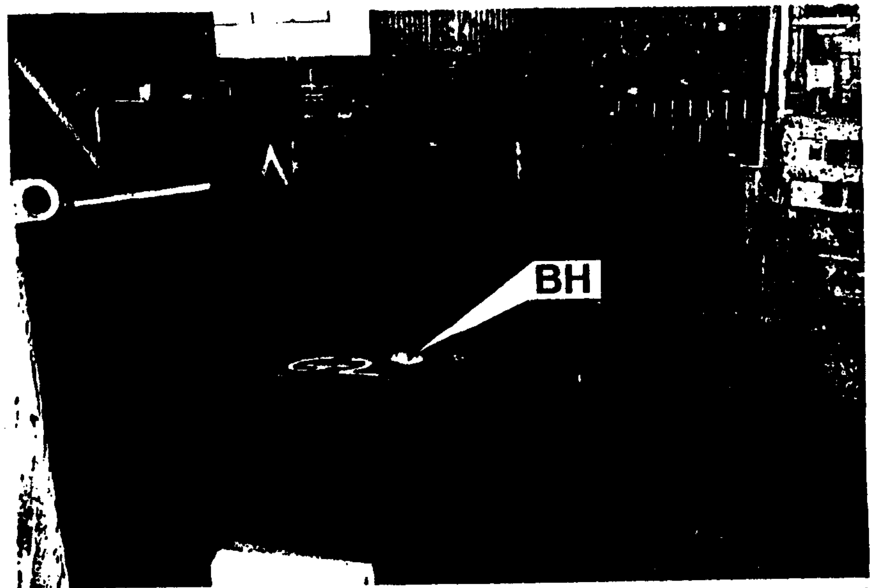

FIGURE 13

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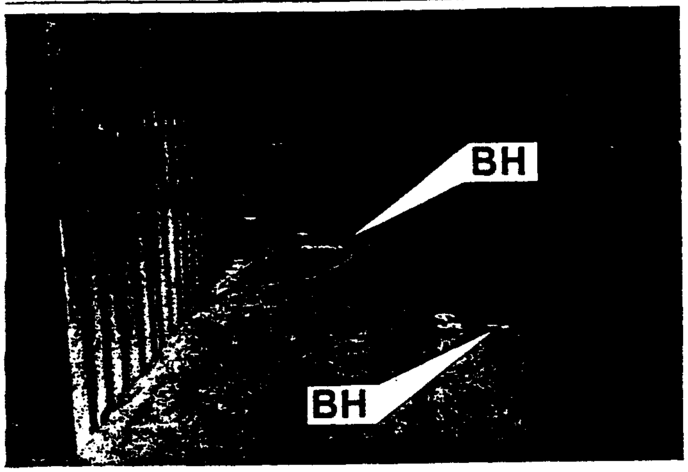
SITE PHOTOGRAPHS



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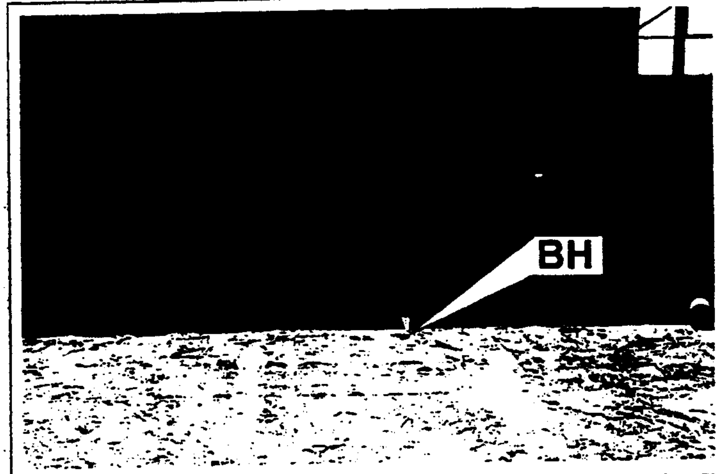
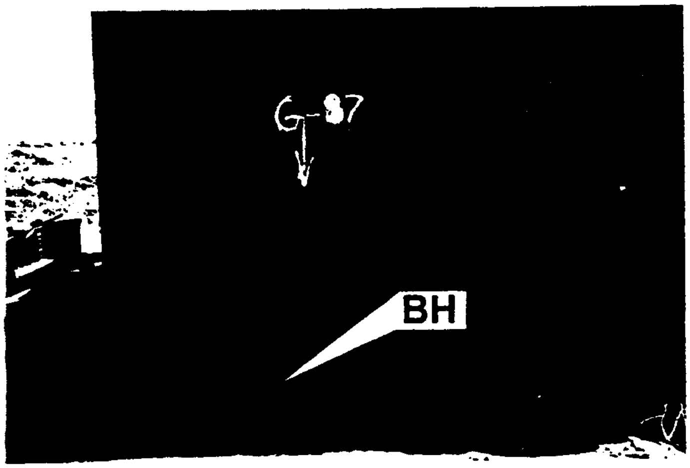


FIGURE 15



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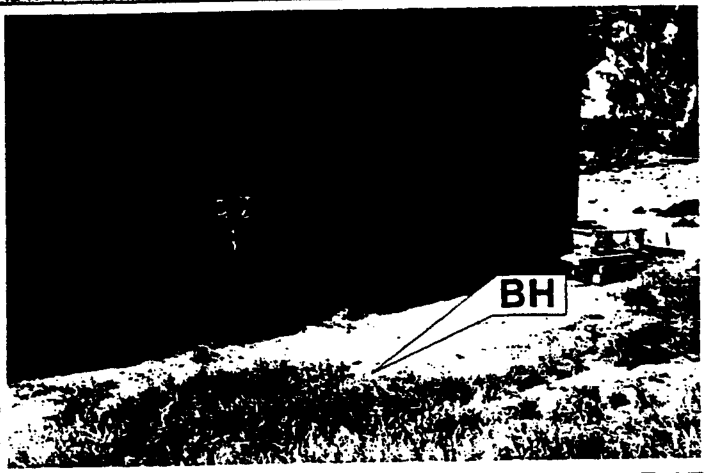

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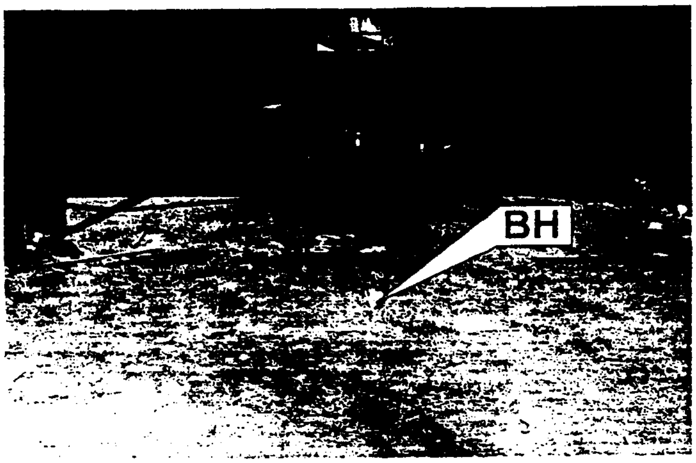

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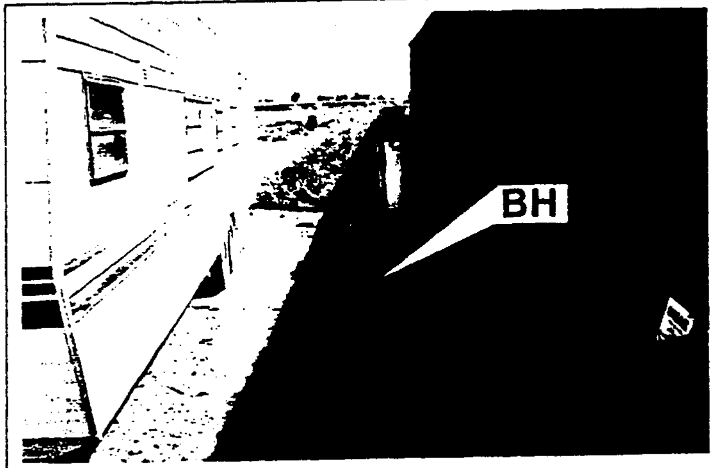

FIGURE 19

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SITE PHOTOGRAPHS

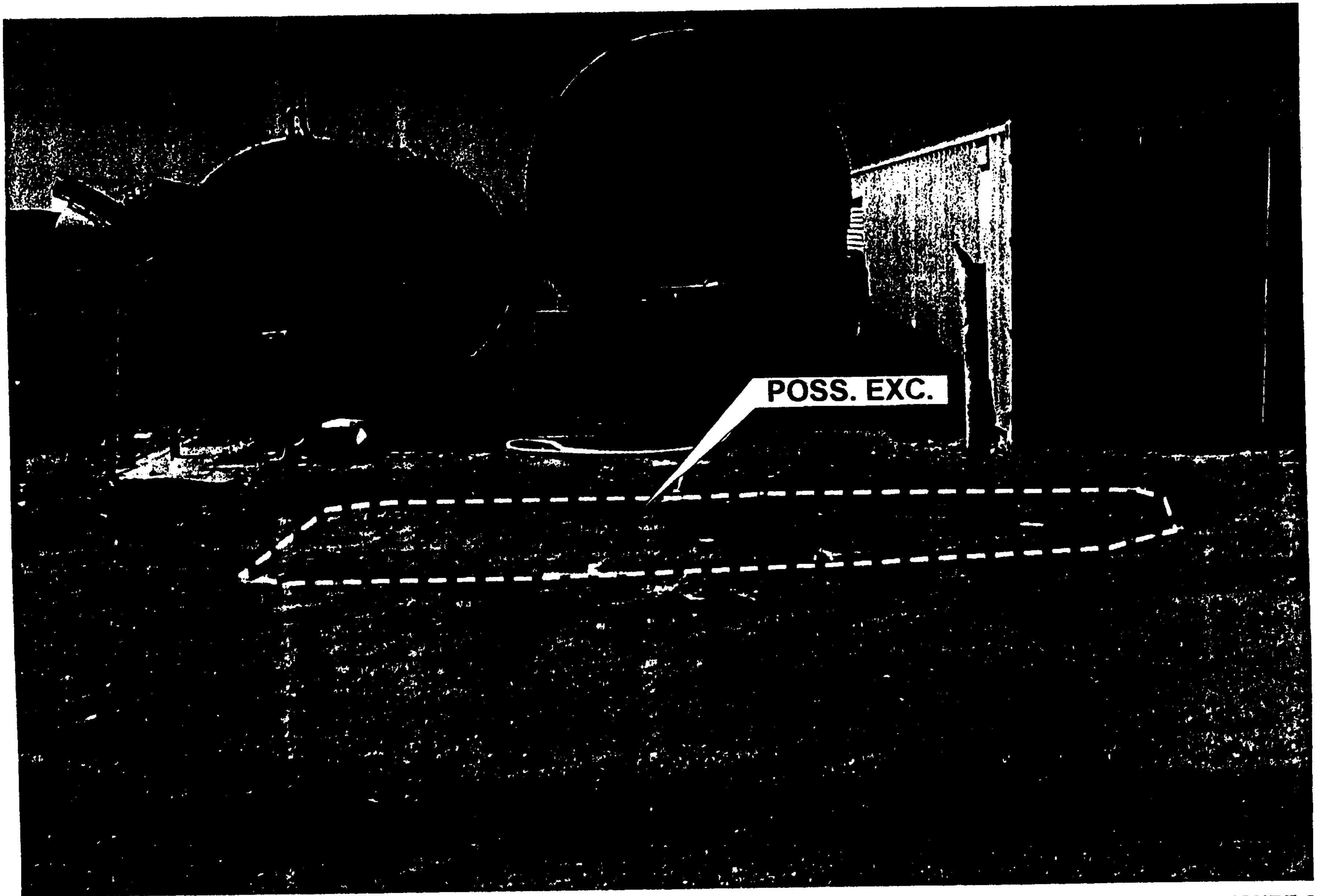

FIGURE 20

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SITE PHOTOGRAPHS

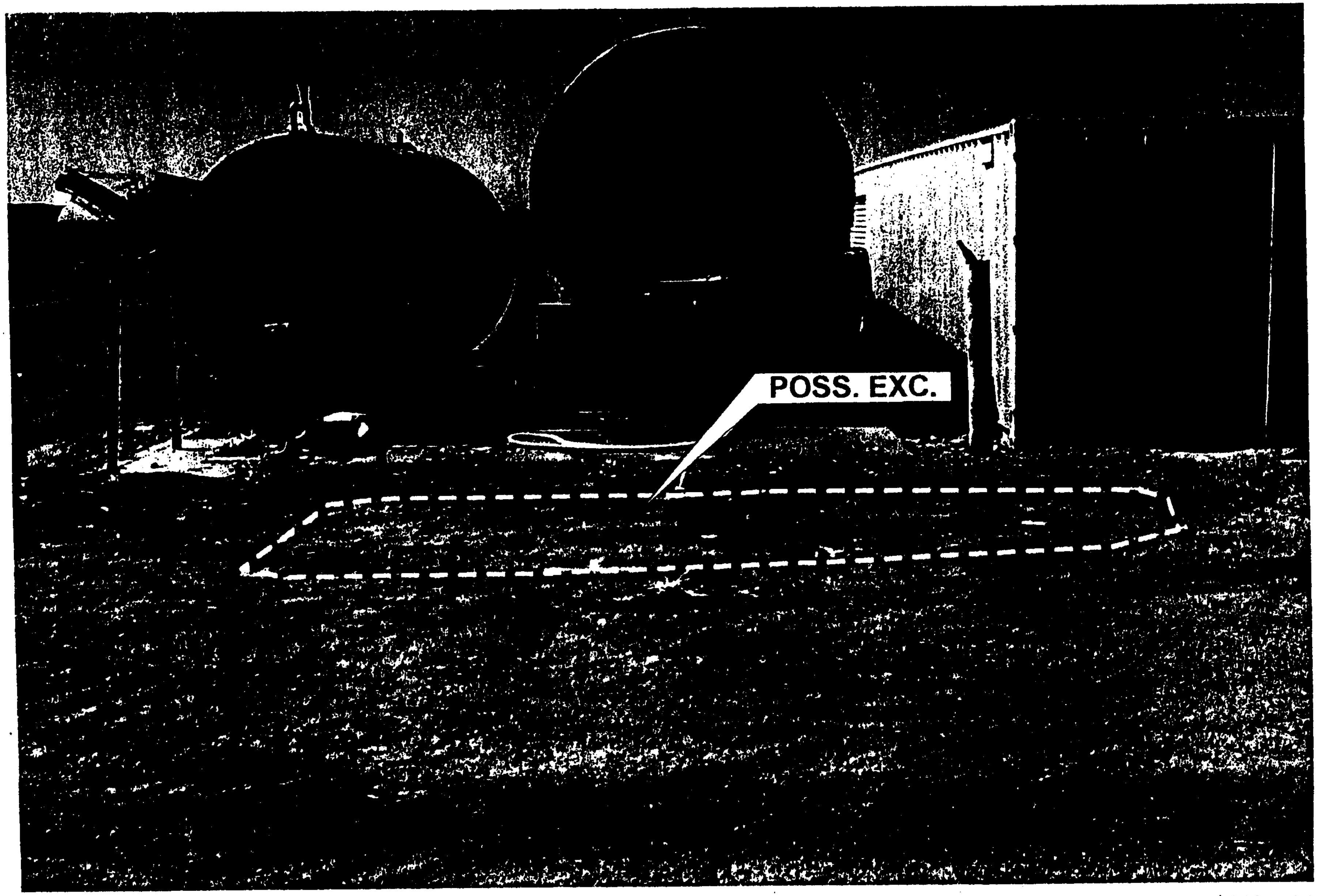

FIGURE 20

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RADAR INTERPRETATION

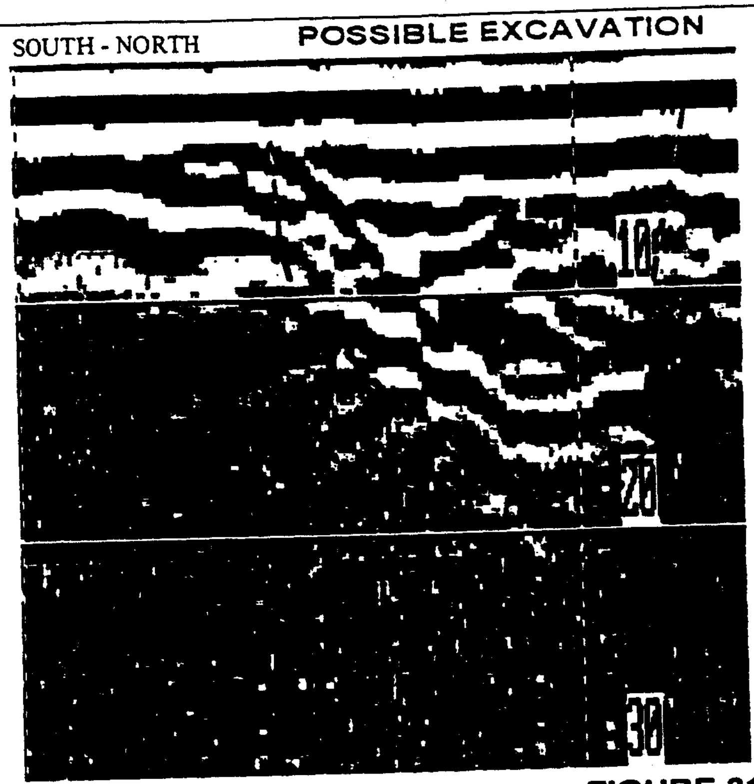

FIGURE 21

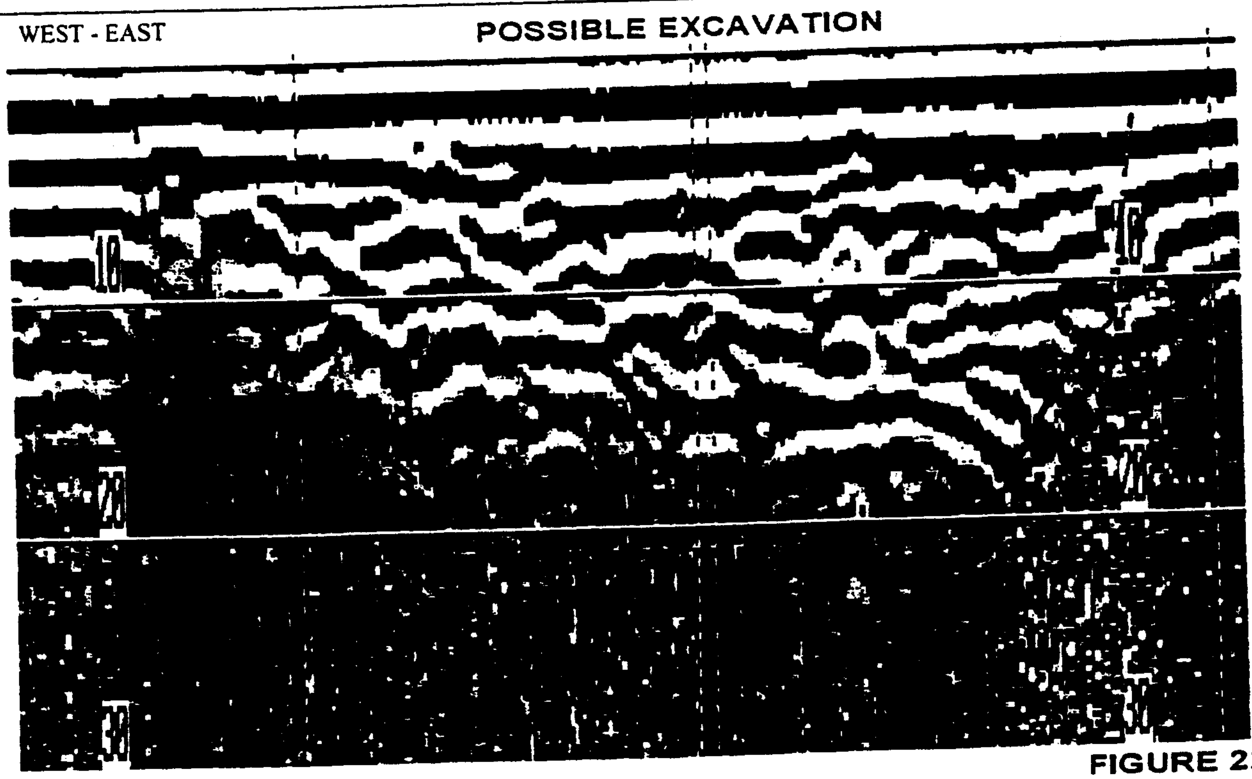

FIGURE 22

SITE PHOTOGRAPHS

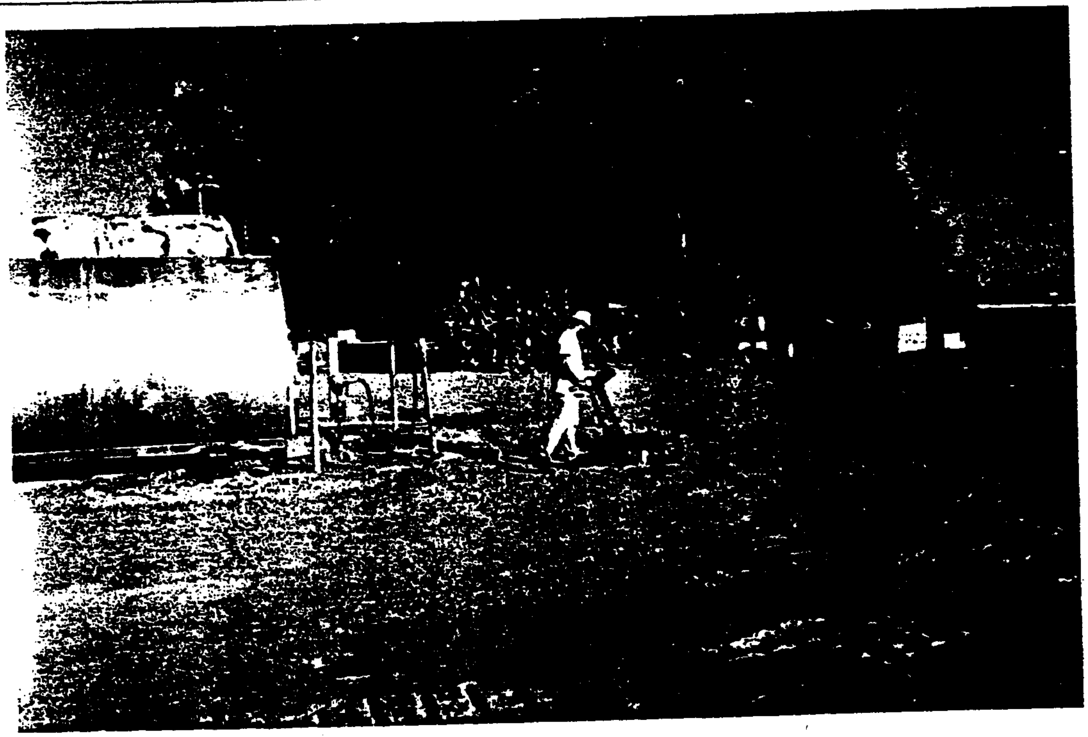

FIGURE 23

FIGURE 24